CORRELATION OF UNIAXIAL COMPRESSIVE STRENGTH BETWEEN UCT AND POINT LOAD INDEX OF ROCK IN KLANG VALLEY

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ABSTRACT

Uniaxial compressive strength (UCS) is one of the most important properties of rock that are widely used in geotechnical field. Since, the direct method to obtain UCS is expensive; Point Load Test (PLT) is the most commonly used method to estimate UCS. There are several general conversion factor suggested such as by the ISRM. However, it is found that index-to-strength study is rock dependent and site specific. This research presents on the correlation of UCS between Uniaxial Compressive Test (UCT) and PLT in Klang Valley based on location and rock type. UCT and PLT were conducted on a total of 40 sets of Limestone and 45 sets of Granite rock. The correlation equation for each location are; UCS = 21.192 $I_{s(50)}$ + 4.1976 for Serdang Lama, UCS = 5.7239 $I_{s(50)}$ + 73.819 for Wangsa Maju, UCS = 13.326 $I_{s(50)}$ + 46.24 for Jalan Kepong, UCS = 8.1125 $I_{s(50)}$ + 12.344 for Cochrane, UCS = 1.7789 $I_{s(50)}$ + 39.112 for Jalan Stonor, UCS = 12.151 $I_{s(50)}$ + 19.04 for Bandar Malaysia South, UCS = 18.921 $I_{s(50)}$ – 0.7189 for Sungai Long, UCS = 3.9971 $I_{s(50)}$ + 21.322 for Balakong, UCS = 6.618 $I_{s(50)}$ + 19.938 for Sector C, Parkcity and UCS = 33.708 $I_{s(50)}$ - 43.029 for USJ 7, Subang Jaya.In addition, a regional map of correlation equation is produced for future references in obtaining the UCS from the PLT.

ABSTRAK

Kekuatan mampatan satu paksi (UCS) adalah salah satu ciri utama yang lazim digunakan dalam bidang Geoteknikal. Oleh sebab kaedah langsung iaitu ujian mampatan satu paksi (UCT) adalah mahal, kaedah tidak langsung seperti ujian beban titik (PLT) direka untuk mendapatkan nilai UCS melalui faktor pekali hubungkait antara UCS dan kekuatan beban titik ($I_{s(50)}$). Terdapat beberapa faktor pekali umum seperti yang dicadangkan oleh ISRM. Namun, didapati bahawa faktor penukaran indeks-kepada-kekuatan adalah sangat berkait rapat dengan batuan itu sendiri. Oleh itu, kajian ini membentangkan hubungkait antara UCS and $I_{s(50)}$ di Lembah Klang berdasarkan lokasi dan jenis batuan. Ujian makmal UCT dan PLT telah dijalankan pada 40 set batu kapur dan 45 set batu Granit. Persamaan hubungkait di antara UCS dan $I_{s(50)}$ berdasarkan lokasi adalah seperti berikut; UCS = 21.192 $I_{s(50)}$ + 4.1976 untuk Serdang Lama, UCS = 5.7239 $I_{s(50)}$ + 73.819 untuk Wangsa Maju, UCS = 13.326 $I_{s(50)}$ + 46.24 untuk Jalan Kepong, UCS = 8.1125 $I_{s(50)}$ + 12.344 untuk Cochrane, UCS = 1.7789 $I_{s(50)}$ + 39.112 untuk Jalan Stonor, UCS = 12.151 $I_{s(50)}$ + 19.04 untuk Bandar Malaysia South, UCS = 18.921 $I_{s(50)}$ – 0.7189 untuk Sungai Long, UCS = 3.9971 $I_{s(50)}$ + 21.322 untuk Balakong, UCS = 6.618 $I_{s(50)}$ + 19.938 untuk Sector C, Parkcity dan UCS = 33.708 $I_{s(50)}$ - 43.029 untuk USJ 7, Subang Jaya. Akhir sekali, sebuah peta yang menunjukkan persamaan hubungkait berdasarkan lokasi telah dihasilkan.

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LIST OF ABBREVIATIONS

A	-	Cross sectional area
ASTM	-	American Society of Rock Testing and Materials
D	-	Diameter
F	-	Correction Factor
ISRM	-	Internatioanal Society for Rock Mechanics
L	-	Length
PLT	-	Point Load Test
UCS	-	Uniaxial Compressive Strength
UCT	-	Uniaxial Compressive Test
W	-	Width

LIST OF SYMBOLS

C_j	-	Cohesion
D_e^2	-	Equivalent Core Diameter
$I_{s(50)}$	-	Corrected Point Load Strength Index
K	-	Correlation Factor
P	-	Maximum Load
R^2	-	Correlation Coefficient
ϕ	-	Friction angle
β	-	Weakness plane orientation
σ	-	Compressive stress

CHAPTER 1

INTRODUCTION

1.1 Introduction

Rock strength is one of the most important parameters that are considered when it comes to rock mechanic design. Examples of common application that requires rock strength parameters are such as rock cutting for Tunnel Boring Machine (TBM), rock drilling design and performance, blasting, underground excavations, dam constructions and many more. Rock strength varies based on different properties of rock. Lack of proper understanding of rock behavior and its strength leads to a higher possibility of the foundation of rock engineering structures to fail. In order to obtain the rock strength, laboratory tests need to be carried out. Among the laboratory test carried out to determine the Uniaxial Compressive Strength (UCS) of rock are Uniaxial Compressive Test (UCT) and Point Load Test (PLT).

UCT is a direct method in determining the strength of the rock. It reflects the bearing capacity of rock. However, it is not preferable as it is time consuming, complex and costly. The process of preparing the rock sample is a tedious job as it needs to be prepared in a specified condition before the testing. The rock core sample for testing will need to follow the suggested dimensions by International Society for Rock Mechanics (ISRM). It also has a specific coring diameter and also affected by other physical and geological properties. Obtaining a solid rock core sample for UCS test in a weathered rock is a difficult task. Therefore, a considerable attention has been given to indirect method of UCS estimation such as the index test of PLT. PLT is often conducted to replace the UCT because it is reliable, cheap and fast method. Results obtained from PLT are used to predict the UCS value of the same rock sample. The correlation between both the rock tests has been tailored by previous researchers whereby UCS = (K) $I_{s50,}$ where I_{s50} is the Point Load index normalized to a cylindrical specimen of 50mm in diameter, subjected to a diametric test and *K* is the conversion factor which is in general range of 20-25 as suggested by ISRM (1985).

Although ISRM have suggested a common conversion factor which gives the estimation value of UCS from I_{s50}, studies have shown that there is a tendency for the conversion factor, K to change depending on the different type and properties of rock. Therefore, this study will propose the local correlation between UCS and $I_{s(50)}$ based on samples tested in Klang Valley.

1.2 Problem Statement

Despite the standards and suggested methods (ASTM, 1984; ISRM, 1985) for determination of reliable UCS through the laboratory test, using direct method in determining UCS creates complexity in terms of sample preparation, having quality rock samples, duration (sampling and coring) and also being costly, the determination of UCS of rocks is still the most common way of determining the strength of intact rock (Nazir, *et al*. 2013). In order to save cost and time, it has been a common practice to estimate UCS using Point Load Index (I_s) using established correlation suggested by ISRM. However, the conversion factor, *K* is not always suitable to be used as the reliability of the correlation is dependent on various factors such as location, weathering grade and specific rock type.

Besides that, UCT can become difficult in sedimentary rock as the obtained rock sample are at an irregular geometric parameters which are not allowed by the ISRM standard to have the test performed on them. Moreover, some rocks tend to fail in the preparation stage before performing the UCT due to high weathering and discontinuities present in the core sample. Hence, there is a purpose of research needed in order to obtain the UCS value using different approach. In addition, due to the lack of information on local rocks, the main concern of this research is to obtain the correlation for UCS between UCT and PLT for Klang Valley. It would be beneficial for quick estimation of UCS for the future references.

1.3 Aim and Objectives

The aim of this research is to establish the correlation for UCS between UCT and PLT test based on rocks located in Klang Valley. The three objectives that are set to achieve the aim of the research are:

1. To classify the UCS and PLT value of rock specimens based on the location and rock type
2. To verify and compare the existing general correlation of UCS and PLT.
3. To develop a regional map of correlation between UCS and PLT for Klang Valley area.

1.4 Scope of Study

The scope of study of this research is mainly focused on finding the correlation of UCS between UCT and PLT based on rock samples in Klang Valley. As a start, a detailed literature review had been studied based on correlations came up by past researchers. Besides that, laboratory test data (UCS and PLT) will be collected for rock samples from Klang Valley. The rock samples that are being studied consist of Granite and Limestone. The anisotropy of the rock will not be taken in count due to data limitation. The rock samples obtained for this research are generally Grade II to Grade III rocks.

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